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A First Standardized Swiss Electronic Maternity Record

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Abstract. Background: During the nine months of pregnancy, women have to regularly visit several physicians for continuous monitoring of the health and development of the fetus and mother. Comprehensive examination results of different types are generated in this process; documentation and data transmission standards are still unavailable or not in use. Relevant information is collected in a paper-based maternity record carried by the pregnant women. Objectives: To improve availability and transmission of data, we aim at developing a first prototype for an electronic maternity record for Switzerland. Methods: By analyzing the documentation workflow during pregnancy, we determined a maternity record data set. Further, we collected requirements towards a digital maternity record. As data exchange format, the Swiss specific exchange format SMEEX (swiss medical data exchange) was exploited. Feedback from 27 potential users was collected to identify further improvements. Results: The relevant data is extracted from the primary care information system as SMEEX file, stored in a database and made available in a web and a mobile application, developed as prototypes of an electronic maternity record. Conclusion: The user confirmed the usefulness of the system and provided multiple suggestions for an extension. An electronical maternity record as developed in this work could be in future linked to the electronic patient record.

Keywords. Information System, Data Transmission, Gynecology, Maternity record, Electronic Patient record

1. Introduction

During the course of a pregnancy, women are likely to visit several physicians and medical institutions for continuous monitoring of growth and development of the fetus. Beside periodical examinations at the gynecologist, which normally take place at intervals of 4 weeks, it is possible to pass further examinations, such as ultrasonic testing and prenatal diagnosis. Whenever a medical examination takes place, data about the woman and her unborn child are recorded. In a maternity record, the relevant vital data of the unborn child resulting from these examinations is summed up. It is issued by the gynecologist or midwife and handed out to the patient once a pregnancy has been diagnosed. The patient is advised to carry it with her all the time, so it can be filled with information continuously. This simplifies the communication between physicians and facilitates the exchange of information. Further, in case of an emergency the relevant data is immediately available.

We generally distinguish between paper-based from electronic maternity record. Although easier to handle, the paper-based version has some disadvantages such as poor readability and unavailability in emergency situations. In contrast to Germany, where the

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paper-based maternity record is officially distributed to pregnant women since 1968, and Austria (since 1974) [1], Switzerland does not have an official maternity record. There are voluntary electronic records available that are in use by several physicians and midwifes, but the collected information is varying as there is no guideline and fixed data sets. This makes it hard to share the data with other physicians.

To benefit from the advantages of a digital maternity record, we develop in this work a concept for exporting and storing relevant data from the primary care information system in a standardized manner. For this purpose, we propose a standardized dataset. We develop a prototype that allows pregnant women and their physicians to access the data in form of an electronic maternity record through a mobile and web application.

2. Methods

In order to specify the relevant dataset, we compared existing approaches for maternity records available in Switzerland, Germany (e.g. [2]) and Austria [3]. The initial dataset has been adapted and revised by two gynecologists as well as by an experienced midwife. By involving physicians and midwifes, we aimed at defining a maternity record for a cross-disciplinary use. For developing the concept for data export, we reviewed data exchange formats available in Switzerland for Primary Care Information Systems. We identified SMEEX (Swiss Medial Data Exchange) as a possible data exchange standard. SMEEX is a standardized data language that enables the conversion of data from one system to another [4]. It allows a cross-institutional exchange of information. A smeex-file can be generated by more than 40% of all Primary Care Information Systems in Switzerland. Apart from the founder, Vitodata AG and TMR AG, some other software producer such as HCI Solutions AG, Logival Informatique SA and Praxinova AG support the standard. The advantage of SMEEX is the structure of its data. Exported smeex-files can be transmitted to other institutions and imported in their information system. The file can then be further processed, keeping the structure of the imported information. The actual smeex-file structure is a zip-file, containing XML- and binary file formats like pdf [5]. Using the data set and this exchange format, we developed our concept for the electronic maternity record and implemented a prototype of a mobile and web application.

By means of a questionnaire, we studied the acceptance of the developed prototypes in women. 27 women filled the questionnaire. Main objective was to find out which additional functionalities are desired and how much women are willing to pay for an electronic maternity record app.

3. Results

3.1. Data set

The content of the maternity record comprises the following data:

- Personal data and general information
- Prenatal diagnosis
- Serologic testing
- Development of the pregnancy

- Medication and vaccination
- Medical examinations
- Ultrasonic testing and images
- Forms

This data is entered to the maternity record after each examination at a gynecologist, midwife or other medical institution and was selected to be available in our digital maternity record.

Most of this information can already be found in today's paper-based maternity records. The specific advantage of a digital maternity record is the possibility of adding ultrasound images and forms, e.g. a certificate of incapacity for work or declarations signed by the patient.

3.2. Concept for the digital maternity record

Our concept for the recording and handling of the digital maternity record aims at reducing the effort for involved people for data transmission and access, and at limiting the error rate due to missing information in the clinical decision making process. Figure 1 shows several use cases for the maternity record as well as the overall concept explained in the following.

1. The recorded data is exported and saved as a .smeex-file at the end of an examination. SMEEX data is directly exported from the Primary Care Information System.
2. The smeex-file is uploaded to the website. This is done manually by the gynecologist, but could be automated in a future extension.
3. The uploaded file, which consists of XML- and binary files, is copied to a file system that triggers the follow-up processing.
4. The data is stored in a central database and can be accessed by the web interface of the app as described in steps 5 to 8.
5. The website displays the information from the record in a structured and graphical manner. The data is grouped into categories to increase the readability and clarity of data presentation. The gynecologist can access the information and discuss the results with the patient. As usual, the maternity record can be printed for the patient.
6. A mobile application allows the patient to access her maternity record.
7. With help of the eHealth-Connector, the data can be transformed to the standardized format CDA-CH and be stored in an electronic patient record repository. From there, it is accessible for other physicians and midwifes.
8. The data can be stored anonymized in a database and be used for research purposes.

In this work, we focused on the extraction of the dataset from the smeex-file and the storage of the information in a database. Therefore, the processing module unzips the uploaded smeex-file and stores the components in a new folder. Each smeex-file consists of an index.xml and a data.xml file as well as, if any, binary data. In the case of a pregnancy, binary data are mainly ultrasound images and forms. The data.xml file contains all data needed for the maternity record. The values are then stored in the database. Implementing steps 7 and 8 were not part of this word and remain open for future work.

Two prototypes have been developed to demonstrate the use cases of the maternity record for pregnant women and access for the attending physicians. The website can be used by physicians to add new data to the maternity record by uploading a new smeex-file. After the upload, the data is extracted and stored in a database and can be verified by the uploader. The website has been implemented using PHP and MySQL to query the database. The visualisation of the information is structured by the categories mentioned in chapter 3.1. This aims at increasing the clarity and making it easier for the physician to find required information. Through interviews with a midwife, we have learned that only little information is required for a first assessment. We therefore decided to provide an overview featuring the most important data, such as the week of pregnancy, risks during pregnancy and number of pregnancies and births.

The pregnant woman can access her maternity record with a mobile application. The information is structured by the same categories as the website. The only difference is the possibility to add personal notes which are only stored locally on her smartphone. This allows a woman to collect questions concerning their maternity record or pregnancy or to add personal observations. During the next consultation, she can discuss her notes with her physician or midwife. In this way, an active involvement of the woman in the treatment process is ensured.

3.3. User feedback

On average the 27 participants would pay 4.37 CHF for the digital maternity record app. The lowest amount was 0 CHF (3/27), the highest rankings were 10 CHF (3/27) and 20 CHF (1/27). Three participants enquired about the availability of the app. As additional functionalities, the participants stated that they would like to be able to access

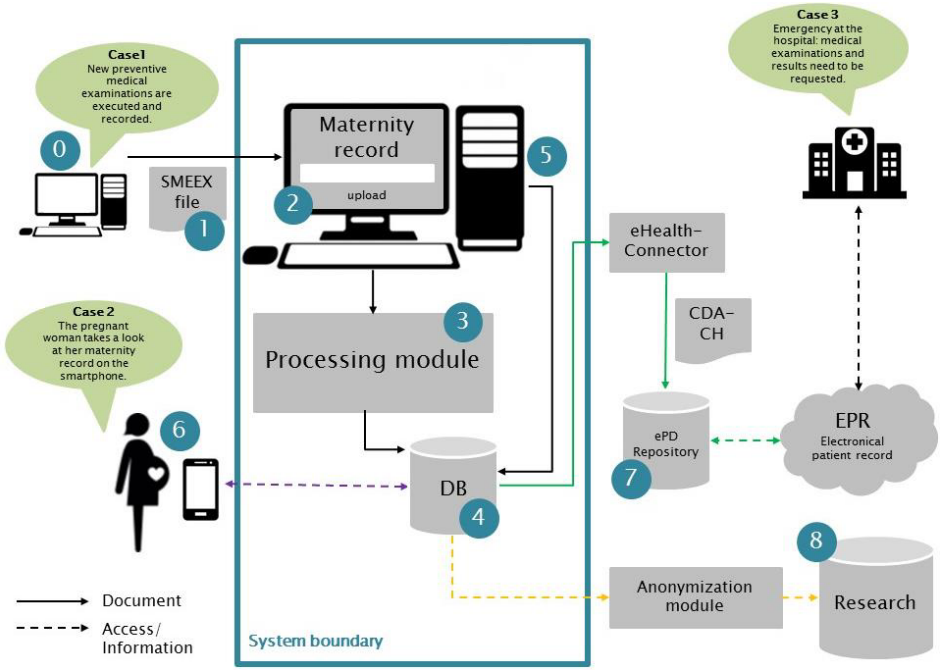

Figure 1. Concept and use cases for a digital maternity record

information about the development of the unborn, accessing information relating to midwives and prenatal classes in the surrounding area. Further, they would like to have a possibility to directly communicate with experts. Overall, the feedback was highly positive, none of the women expressed concerns.

4. Discussion

The high interest in our work, the positive feedback from the survey and findings from existing literature [6-8] indicate the importance of an electronic maternity record for pregnant women. The increasing number of births and the desire to move between different locations will cause a highly distributed data set and leads to an increased need for data exchange. An electronic maternity record can improve this exchange and availability of the data.

A clearly structured presentation of all relevant data in a mobile application is an advantage for the patients. Attending physicians and midwives can benefit from less effort and there is a lower likelihood of errors, because the data is automatically added into the maternity record. To consider the fact that not all women can or wish to use an electronic maternity record, a data export in form of a physical copy should therefore be enabled.

The developed concept is based on the assumption that the entered data is available in a structured format provided by the primary care information system. Currently, the content and types of documentation still differ very much. Another problem is the usage of empty text fields which makes it hard to extract specific information. To simplify further usage, it is necessary to ensure that all data entered is structured. The maternity record can be added to the electronic patient record as shown in figure 1. To achieve this, the document must be transformed to the format CDA-CH for example with the eHealth

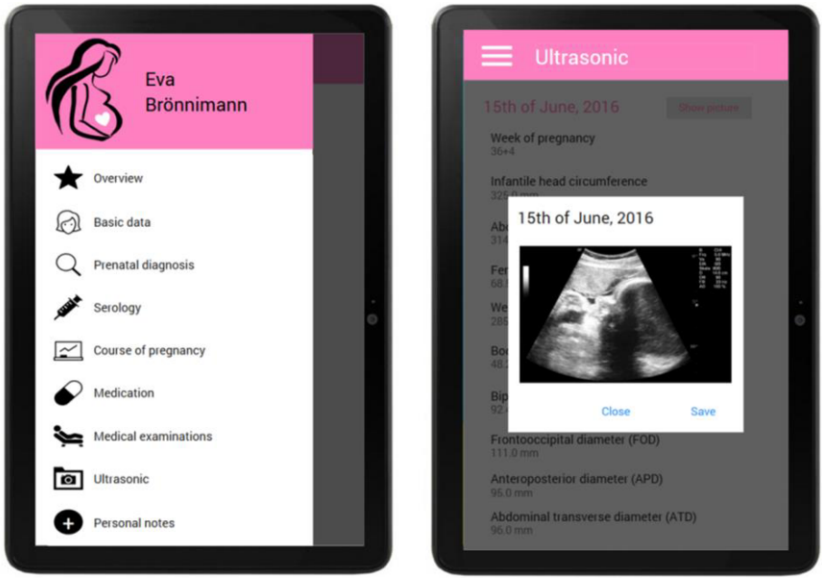

Figure 2. Screenshot of the mobile application. Ultrasonic images can be accessed as well as the entire data set as specified

connector available at Sourceforge (https://sourceforge.net/projects/ehealthconnector/). The transformed document can then be stored at the medical office or in a repository and be linked to the electronic patient record.

The process developed in the context of this work requires further elaboration for it to become established on a national level. The manual data upload can be automated to reduce the effort for the physician. Security aspects need to be reviewed and implemented. Furthermore, the concept for the mobile application must be revised. The positive feedback from pregnant women proves that the app will be well received.

Functionalities such as a clear explanation of the recorded data or options for self-reporting should be implemented. In the latter case, it must be determined whether or not the self-observed data, e.g. the weight, is reliable enough to be added to the electronic patient record.

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